Developing Reliable Ergonomic Exposure Assessment Strategies for Construction Work

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Reliable ergonomic exposure assessment methods are desired for epidemiologic and intervention research. The use of continuous observational or direct measurement methods for all workers in a study group under all working conditions for long periods of time is not logistically or economically feasible. Careful consideration must be given to the sampling strategy used to estimate exposure (e.g., number of people measured, length of measurement time).

Obtaining reliable measures of group and individual exposure requires knowledge about how exposures vary over time and among workers within a particular group. The objective of this research was to provide guidelines for the reliable assessment of ergonomic exposures in construction work using a modified work-sampling approach. Variability in exposure among tasks, workers and within days was evaluated. Computer simulation methods were used to compare the reliability of exposure assessment strategies for ergonomic exposures that had different variability characteristics.

Two or three observers collected observational data at discrete intervals on three trades (iron workers, carpenters and laborers) during a total of 10 different construction tasks over several weeks. In total, 4852 observations were made. At each observation, recorded exposure variables included non-neutral trunk posture, trunk flexion, lateral bending or torsion, arm(s) at or above shoulder height, kneeling, squatting or leg bending, load handling, manual materials handling, hand-tool use and power-tool use (each coded yes/no).

The frequency of exposure was calculated for each worker during each of

the tasks on each day of exposure. ANOVA was used to assess the importance of task, between-worker within task and within-worker components of exposure variability. A statistical resampling method (bootstrap) was then used to evaluate the reliability of exposure estimates for groups of workers performing the same task. The primary aim was to determine the least number of observation days needed to reliably characterize exposures of different frequencies and between-day variances.

Most ergonomic exposures were found to vary significantly among construction tasks, indicating that the task-based approach can be used to improve exposure assessment efforts. In most cases, the between-worker component of variance within task was overshadowed by a large within-worker component of variance, thought to consist largely of day-to-day differences in exposure (in addition to measurement error). This suggests that characterizing exposures for each task on multiple days is important for reliable exposure estimates. When daily exposures of high frequency were bootstrapped, the reliability of the exposure estimates usually improved greatly (i.e., dramatic narrowing of the 95% confidence interval) as assessment periods approached 5 to 6 days. There were only marginal improvements in reliability for assessment periods longer than 6 days. When daily exposures with low frequency were bootstrapped, reliable estimates of exposure were obtained with observation periods of 1 or 2 days. A preliminary analysis of exposure frequency and variability is recommended when determining the appropriate sampling strategies for the evaluation of ergonomic exposures in construction and other non-repetitive work.

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